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CAN THE USE OF QR CODES ENHANCE M-LEARNING IN A BLENDED LEARNING ENVIRONMENT?

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Abstract

In recent years, with the introduction of smartphones, tablet computers and the advancement of information and communication technology (ICT), there has been a growing interest in the use of Quick Response (QR) codes for educational purposes. The majority of scholarly accounts in this particular topic have been those related to managing libraries, and to a lesser extent to teaching and learning. At present, applications of QR codes in higher education are minimal, and even fewer in a blended learning environment. This paper describes an exploratory project that attempts to introduce three specific examples of basic QR code-driven activities in an Open and Distance Learning (ODL) institution. Learners were asked to scan QR codes using mobile smartphones or tablet computers. Three different types of content, i.e. text-based instruction, Uniform Resource Locator (URL) of video lectures (called iLectures) and URL of self-test activities were made available to learners via the QR codes. A cross-sectional survey was carried out on learners who have been introduced to the QR codes. The objectives of this project are multi-pronged: first is to create awareness of QR codes among learners; second is to encourage and push the use of specific online materials via mobile devices; and third is to determine learners' attitudes/perceptions towards the use of a combination of smartphones and QR codes in learning. This study is important to an ODL institution like Open University Malaysia (OUM). For a provider of flexible delivery of instructional materials, QR codes can play a significant role in enhancing mobile learning (or m-learning) and engaging learners in their learning process. The research findings are expected to indicate whether or not the integration of smartphones and QR codes can be considered an effective way forward in achieving a semi-ubiquitous m-learning environment.

Keywords: QR Code, open and distance learning, m-learning, blended learning

1. INTRODUCTION

The growing abundance and rapid development of mobile technology holds great implications and potential for higher education. A higher education institution can leverage on the ubiquity of mobile devices to further advance its mobile learning (m-learning) initiative to offer a new dimension in content delivery and teaching and learning – something that has been undertaken by many savvy institutions. In Malaysia, the mobile telephone penetration rate stands at over 117%, and its sales represent more than 60% of all consumer electronic purchases. Of more than 7.5million mobile telephones sold in Malaysia in 2010, two in five were smartphones – a figure that is expected to climb to over 50% by the end of 2012.

At Open University Malaysia (OUM), mobile telephone ownership amongst its learners stands at over 95%; and a small but growing number of learners are also beginning to own tablet computers. Extrapolating from the overall scenario in Malaysia, it is very likely that the ownership of smartphones will also increase amongst OUM learners in the near future. The ubiquity of these mobile devices signals a novel opportunity to advance m-learning. For OUM, this is an opportunity to advance from a rather basic current system of m-learning whereby learners receive information, motivational messages and reminders via short messaging service (SMS) to a more sophisticated system utilising new mobile applications.

At present, OUM's exploration in m-learning can be described as still in its infancy, having only recently been piloted in 2009 and used mainly as a way to 'push' information to learners. More sophisticated examples of m-learning has been able to incorporate different aspects of teaching and learning beyond the mere feeding of information, e.g. assessment, remediation for critical courses, preparation for tests, access to indices, lists and how-to guides, collaborative learning and sharing of information and supplemental materials. As mobile technology and devices continue to develop, so too will their potential in teaching and learning. At present, OUM's learning position is positioned between desktop and mobile learning (Mansor Fadzil & Latifah Abdol Latif, 2011) – leveraging on current developments in mobile technology and devices can certainly prove to be key for OUM to advance towards achieving a greater degree of ubiquity in teaching and learning.

One example of a mobile application that may have rich potential in education is Quick Response (QR) codes, which are two-dimensional barcodes that can contain simple amounts of data such as multilingual text, a linked Uniform Resource Locator (URL), an automated SMS text, a business card or contact information (Law & So, 2010). This paper will describe an exploratory study that attempts to leverage on the increasing ubiquity of mobile technology by introducing the use of QR codes in a blended learning environment in OUM.

2. LITERATURE REVIEW

QR codes are a relatively new innovation; invented by a Japanese industrial technology solutions provider, Denso Wave, in 1994. Since its introduction, QR codes have been used mainly in an industrial environment, e.g. tracking commercial products, managing industrial processes and et cetera. In Japan, virtually everyone carries mobile telephones with cameras and two-dimensional

barcode scanning technology. This is the reason for the widespread use and acceptance of QR codes in product identification and advertising in Japan (Rivers, 2009).

In recent years, QR codes have also begun to gain popularity for marketing purposes; even outside Japan. An example of their use is embedding related information or links in advertisements, billboards and signboards. This is due to the advancement in mobile technology, specifically in smartphones that have the computing and connective capacity of a small computer. These devices usually have high-resolution touchscreens and cameras, web browsers, Global Positioning System (GPS) navigation, WiFi and broadband access – all of which are regular features that make it easy and quick to seek and retrieve the information that can be contained in QR codes. In more advanced societies, smartphones have a virtually blanket usage (e.g. South Korea, Europe and North America), thus making it even more practical to exploit them for promotional activities. Today's tablet computers (such as the Apple iPad) also have the same (if not more sophisticated) features as the smartphone.

From an education perspective, exploring the use of mobile technology for learning (i.e. m-learning) requires fulfilling three significant attributes, i.e. are location independence, time independence and meaningful content (cited in Law & So, 2010). With the newfound popularity and increasing ubiquity of smartphones as well as tablet computers that have very similar capabilities and features, the use of a novel application like QR codes offers a new dimension for the advancement of m-learning. According to Law and So (*ibid.*), QR codes have great potential in educational endeavours as they are incredibly simple and quick to use – a feature that makes them ideal for teaching and learning. Another reason is that they offer a way to link the physical and virtual worlds by providing on-the-spot access to various information and resources; thereby taking teaching and learning out of the classroom (EDUCAUSE Learning Initiative, 2009). They also offer expanded pedagogical value in activities that encourage learners to create, contribute and share content. Additionally, QR codes operate through scanning actions using built-in cameras in smartphones and tablet computers, thus avoiding the hassle and potential errors of keyboard input. In the context of m-learning, the potential of QR codes to fulfil the four significant aspects stated above is indeed great.

Despite of all the advantages of using QR codes, its actual use in education is still in its infancy and examples are scarce. The University of Bath (<http://blogs.bath.ac.uk/qrcode/>) is one of the most advanced institutions in this regard; having started its project in 2008. Its team has explored various ways of using QR codes, e.g. to catalogue books in the library, for student assignment

submission and even as marketing material from different departments. Other possible uses, as described by other researchers, include:

- Subscription to course-related Really Simple Syndication (RSS) news feed;
- As additional/complementary inclusion in printed learning materials; and
- As just-in-time information (e.g. related links to online resources and presentation materials) during a face-to-face session.

In Malaysia, several research studies have been carried out to explore the use of m-learning. For example, a study conducted in 2008 found that the majority (64%) of learners surveyed in OUM were ready for m-learning (Zoraini Wati Abas, Chng & Norziati Mansor, 2009). This was followed by another pilot study in 2009 to examine OUM's efforts at enhancing the blended learning approach with the *Mobile Learning via SMS* initiative (Lim, Mansor Fadzil & Norziati Mansor, 2011). Aspects such as the conceptual model, the process flow of group messaging, challenges faced and effectiveness of the initiative, were discussed in this paper. Another study on m-learning found that there were significant differences in the usage of mobile telephones for m-learning between heavy and light mobile telephone users (Norbayah Mohd Suki & Norazah Mohd Suki, 2007). The study also revealed that heavy mobile telephone users accessed/subscribed to more than one type of mobile content; have more frequent access, more likely to subscribe to and purchase mobile content; as well as more likely to spend more money on m-learning, its content and mobile games than light mobile phone users.

However, the use of QR codes in teaching and learning is something that has yet to be studied in Malaysian institutions. Of late, QR codes have been quite commonly used in marketing and promotions, particularly in print and billboard advertisements, but nothing yet has been accomplished in an educational context. Outside Malaysia, with institutions like the University of Bath leading the way, the use of QR codes is likely to grow in the near future. Thus, from this literature review, it can be seen that QR codes has significant potential for m-learning. Nevertheless, more research needs to be done to examine how QR codes can be used to enhance m-learning in a blended learning environment such as in OUM. This is one of the first attempts to look into the possibility of using QR code to enhance mobile learning; the findings of which should be of great benefit not only to ODL but other higher education institutions which aspire to enrich their teaching and learning.

3. OBJECTIVES OF PROJECT

The main objectives of the project are (a) to determine learners' awareness of QR codes; (b) to investigate how QR codes could be generated and used by learners to access study materials for

learning purposes; and (c) to determine learners' perceptions towards QR code usage for enhancing m-learning in a blended learning environment. The project was intended to be exploratory in attempting to achieve these objectives.

4. METHODOLOGY AND APPROACHES

In line with the project objectives, learning materials were confined to video lectures known as iLectures, and related question-and-answer (Q&A) exercises for eight different courses taught at OUM. The eight courses were:

- Elementary Statistics;
- Essential Mathematics (Simultaneous Equations and Straight Line);
- Motor Learning and Control;
- Algebra and Functions;
- Sampling Distribution and Hypothesis Testing;
- Criteria of Capital Budgeting;
- Entrepreneurship; and
- Object Oriented Programming.

These eight courses were chosen because they were deemed to be *high risk courses* (high failure rate) for which learners require additional learning support to help them secure good grades. The iLectures are video lectures that have already been developed by OUM for this purpose. These are stored in the university's data server, and some are made openly available via OUM's YouTube channel (accessible at <http://www.youtube.com/user/OUMportal>). The Q&A exercises were developed by eight OUM faculty members who also serve as face-to-face tutors to learners registered in the abovementioned courses.

The project was carried out between January and March 2011 in three phases, i.e. (a) Phase 1: Generating QR codes for text-based instructions, URL to iLectures and Q&A exercises (by OUM); (b) Phase 2: Decoding QR codes, watching iLectures, and attempting the questions provided in the Q&A exercises (by the learners), and (c) Phase 3: Collecting data on learners' awareness of and perceptions on the use of QR codes in m-learning through a cross-sectional survey.

The basic requirements to using QR codes are:

- A smartphone or tablet computer (e.g. the Apple iPad);

- A built-in camera;
- A QR code reader; and
- Internet or WiFi connection.

The following diagram depicts the processes involved in this project. The subsequent sections will provide greater explanation on the relevant details.

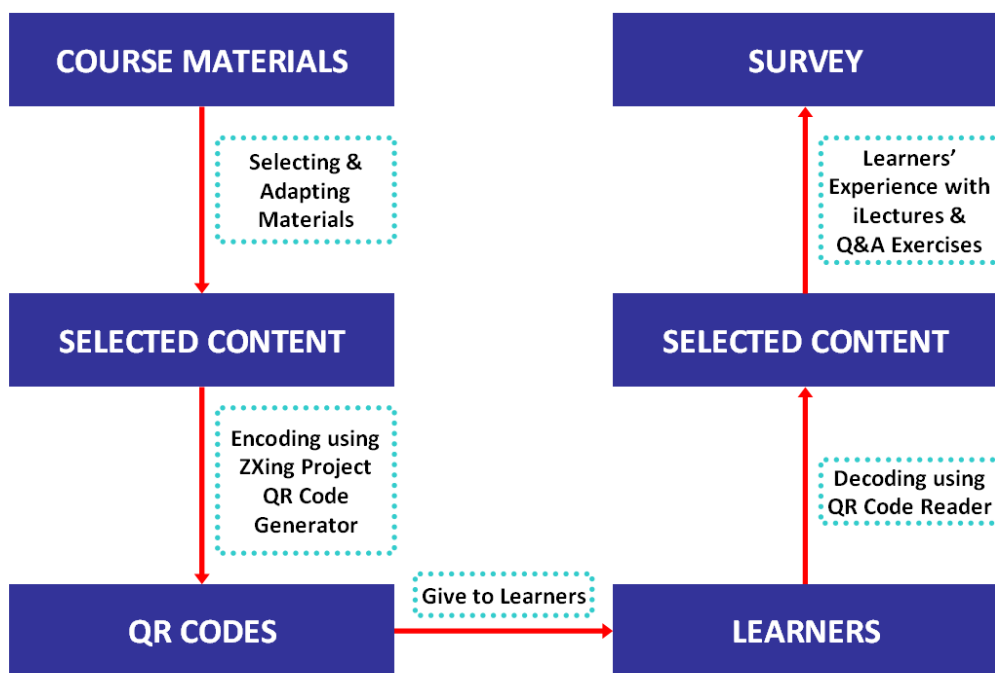


Figure 1: The processes involved in this project

4.1 Phase 1: Generating QR Codes

There are many web-based QR code generators available. OUM selected the ZXing Project (accessible at <http://zxing.appspot.com/generator/>) to encode the text-based instructions and URL links to iLectures and Q&A exercises for the eight courses selected in this project. For each course, one set of QR codes was generated, except *Essential Mathematics*, for which two sets were created. Thus, a total of nine sets of QR codes were generated, each containing three codes for (a) general instructions; (b) URL link to iLecture; and (c) URL link to the Q&A exercise. Participating learners that were registered in these courses were given one specific set of QR codes to gain access to the appropriate instructions, iLecture and Q&A exercise.

Besides the ZXing Project website, there are other web-based QR code generators, including:

- Kaywa (at <http://qrcode.kaywa.com/>);
- NFG Games (at <http://nfggames.com/system/qrcodegen.php>); and
- Delivr (at <http://delivr.com/qrcode-generator>).

4.2 Phase 2: Decoding QR Codes

In this phase, participating learners were required to check whether or not a QR code reader was already installed in their smartphones or tablet computers. Those who did not have a QR code reader were requested to download and install it into their devices. Free QR code readers are already widely available for various devices according to their type of operating system (OS). The following is a list of recommended QR code readers according to OS.

Table 1: Recommended QR Code Readers by OS

OS/Device	Source	Name of Reader(s)
Blackberry OS	App World	NeoReader, BeeTagg, QR Reader
Android	Google Play Shop (previously Android Market)	QR Droid, Barcode Scanner
iOS for iPhone	App Store	QR Reader for iPhone
iOS for iPad	App Store	Scan by QR Code City

Once the QR code reader was installed, learners were directed to scan (in correct sequence) the given QR codes assigned to them using their smartphones or tablet computers. Learners were asked to read the given instruction, watch the iLecture and then attempt the exercise given in the final QR code. The following are examples of the actual QR codes and their embedded information, as used in this project.



Figure 1: Examples of QR codes given to the learners

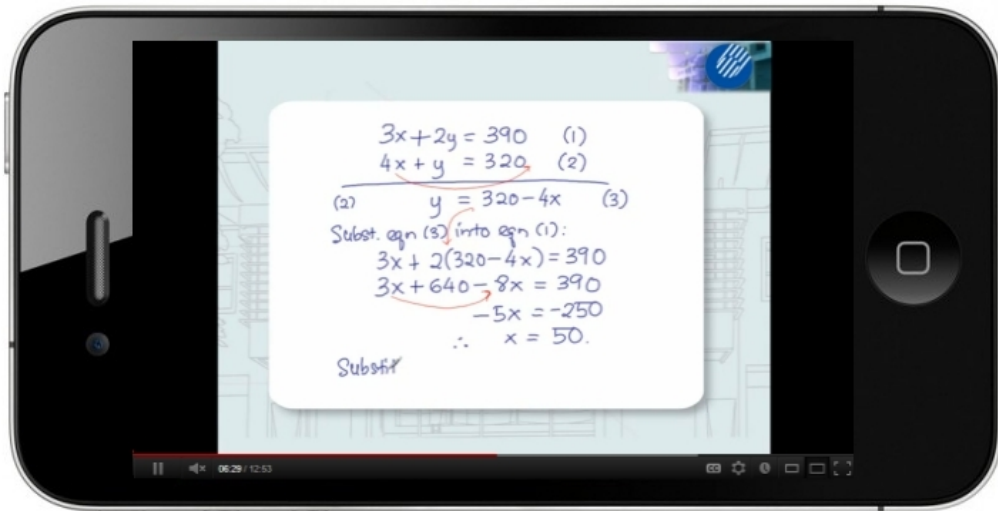
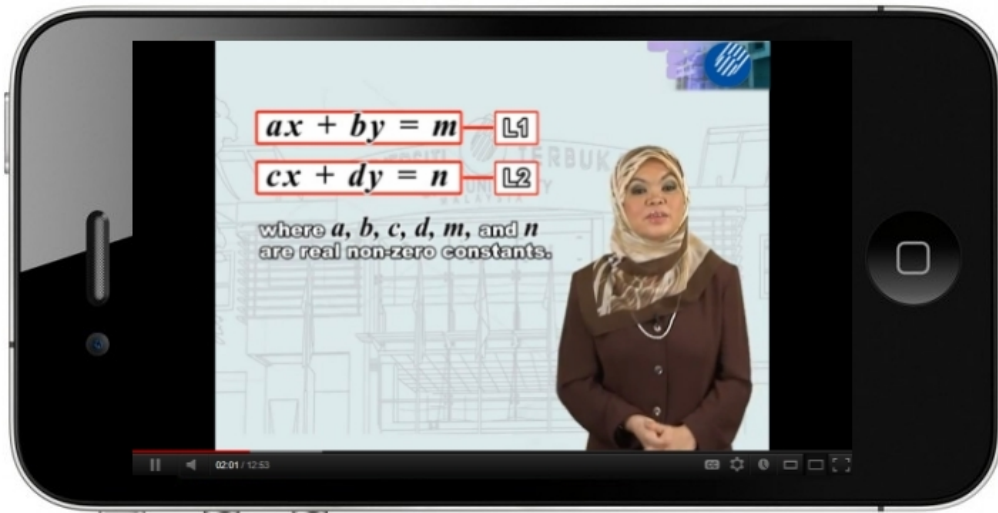


Figure 2: Examples of iLecture screenshots for Essential Mathematics (Simultaneous Equations) as they would appear on an Apple iPhone

2. Consider $H_0: \mu = 29$ versus $H_1: \mu \neq 29$. A random sample of 25 observations taken from this population produced a sample mean of 25.3. The population is normally distributed with $\sigma = 8$.

Solution:

- Calculate the p-value
- Considering the p-value, would you reject the null hypothesis if the test were made at the significance level of
 - 0.05
 - 0.01

Solution:

Given pop. is normally distributed
 \therefore sampling distribution of \bar{x} equals μ .

So let us start with solving this problem.

1st - get the value for $\sigma_{\bar{x}}$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{8}{\sqrt{25}} = 1.6$$

2nd Find z

$$z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{25.3 - 29}{1.6} = -2.3125$$

3rd Draw on the curve



4th Find p-value from tables

$$p = 0.0104$$

\therefore (2 tailed test)

$$p = 2(0.0104) = 0.0208$$

i) at 0.05 - reject H_0

ii) at 0.01 - do not reject H_0

Figure 3: Example of a Q&A Exercise for Sampling Distribution and Hypothesis Testing
(encoded by two separate QR codes)

4.3 Phase 3: Collecting Data

A combined sample of 62 learners from different tutorial classes of the eight chosen courses participated in a questionnaire-based survey. The sample was made of 34 male and 28 female learners. In terms of age, 23 persons (37.1%) were in the 19-29 age group, 28 persons (45.2%) in the 30-39 age group and 11 persons (17.7%) in the 40+ age group, respectively.

The learners covered in the survey provided the hard data on ownership of smartphones and tablet computers, as well as knowledge of having seen and used QR codes before they were briefed about QR codes at the start of the project. The statistics obtained were used to gauge the level of

learners' awareness of QR codes in OUM. The 62 learners also provided data on their perceptions towards QR codes in teaching and learning.

The questionnaire adopted for this survey was based on the Technology Acceptance Model (TAM) (Davies, 1989) with four constructs, namely attitude; usefulness; ease of use; and intention to continue using QR codes. Three more constructs, i.e. satisfaction; computer efficacy; and anxiety were also covered in the survey, giving a combined total of seven constructs. To measure the first six constructs (as shown in Table 2), the participating learners were asked to provide responses to a set of statements based on a four-point scale, i.e. (Strongly Disagree); 2 (Disagree); 3 (Agree); and 4 (Strongly Agree). For the construct on satisfaction, the learners were asked to provide a rating of either 1 (Very Dissatisfied); 2 (Dissatisfied); 3 (Satisfied); or 4 (Very Satisfied).

Table 2: Constructs Adopted for the Study

Construct	Number of Statements
Attitude towards use of QR codes	7
Usefulness of QR codes	5
Ease of use of QR codes	3
Intention to continue using QR codes	4
Computer efficacy	4
Computer anxiety	4
Satisfaction	2

5. SURVEY RESULTS

The survey revealed that ownership of smartphones and tablet computers amongst the learners in the sample was low. Only 48.4% of the 62 learners who participated in the survey owned a smartphone; while ownership of tablet computers was much lower at 27.4%. These figures suggest that accessing learning materials via smartphones or tablet computers is currently not universally applicable to all learners in the university. While the survey found that the majority of learners (59.7%) have seen or heard of a QR code, only 22.6% of them have ever scanned a QR code. This indicates that while the majority of learners in OUM are aware of QR codes, they have not used them, either for learning or any other purpose.

Cronbach's Alpha values for the constructs covered in the survey were found to range from 0.767 to 0.914 (Table 3). These alpha values exceeded the minimum value of 0.700 as recommended in Nunnally (1988). Based on these results, the constructs were considered reliable for further analysis.

Table 3: Cronbach's Alpha for Selected Constructs

Construct	Cronbach's Alpha
Attitude towards use of QR codes	.914
Usefulness of QR codes	.881
Ease of use of QR codes	.863
Intention to continue using QR codes	.869
Computer efficacy	.767
Computer anxiety	.862
Satisfaction	.708

As shown in Table 4, the mean ratings for learners' *attitude*, *satisfaction*, *usefulness* and *ease of use* of QR codes were high, i.e. ranging between 3.10 to 3.23 out of 4.00 points. The survey also found that learners' *intention* to continue using QR codes, at 2.97 points, was above average. These statistics suggest that learners in OUM viewed QR codes favourably if they are used for learning. To obtain an indication of learners' ability to use technology, the mean rating for *computer efficacy* was computed. It was found that the learners were moderately efficient in using computer technology with an average rating of 2.97 points. Learners' anxiety was fairly low at 2.35 points.

Table 4: Mean Ratings of Constructs

Construct	Mean	Standard Deviation
Attitude towards use of QR codes	3.23	.422
Usefulness of QR codes	3.10	.403
Ease of use of QR codes	3.12	.444
Intention to continue using QR codes	2.97	.469
Computer efficacy	2.96	.507
Computer anxiety	2.35	.591
Satisfaction	3.13	.461

A multiple regression analysis was performed to identify the factors that may affect learners' intentions to continue using QR codes. It was found that *usefulness* and *satisfaction* have significant impact on learners' *intention* to continue using QR codes. As the regression was performed based on a small sample of 62 respondents, the statistical results obtained should be interpreted with caution. Nevertheless, these results provide some useful insight on the factors that influence learners' intention to use QR Codes.

The learners were asked whether they were satisfied with the use of QR codes for learning and their reasons for saying so. The majority were satisfied; and explained that the system was easy to use; learning with QR codes was fun; and the system also renders greater mobility in learning, as the URL links of iLectures and Q&A exercises are automatically saved into the device and can

be retrieved whenever or wherever required. Learners also cited the following reasons: improved learning performance; suitability for working adults who are busy during working hours; and that it is a very smart system that is suitable for learners with smartphones and tablet computers.

There are, however, some learners who had some reservations for this approach. In the first place, these learners do not own smartphones or are reluctant to pay for the required Internet charges. They suggested that OUM subsidises smartphone purchase and Internet charges if the university is to use QR codes in its delivery approach. A few also complained that they were not able to access the Internet at their respective learning centres and hence, could not access the embedded information in the given QR codes. Some also complained that the knowledge gained was rather limited. Lastly, some also asserted that the smartphone might not be suitable as a device for learning as its screen is rather small and its battery life is limited.

Learners also suggested a number of ways of improving uptake of using QR codes. Apart from subsidising smartphone purchases and Internet charges, learners suggested that OUM provides better WiFi facilities and tablet computers for use at learning centres; and that more QR codes are created for additional iLectures, exercises, and Internet radio segments (available at OUM's Internet radio station, iRadio). To facilitate easy reference of QR codes, they also suggested that a catalogue of QR codes is produced and circulated to them.

In addition to the qualitative feedback given by the learners, there was also an attempt to obtain feedback from the faculty members/tutors who participated in this project. Valuable insight on the usefulness and weaknesses of the integrated system of QR codes with smartphones and tablet computers were obtained from these individuals. They reported that most learners were excited with the system and that a great deal of interest was generated during the tutorial sessions. They also reported that learners had a strong positive reaction to using QR codes; where some learners even requested for more questions after their first experience. Learners also thought that learning was more enjoyable; and the QR codes had many positive attributes that suited their personal needs as working adults. The tutors' feedback is consistent with the findings from the questionnaires that have been discussed earlier.

6. DISCUSSION

A key element to understanding if users will accept and use a certain tool and technology is to evaluate users' perception, ease of use and usefulness towards that particular tool and technology. This study involves the use of QR codes which may help advance the m-learning in OUM.

Although there are many types of mobile devices that can be considered, this project has limited them to personal mobile devices, specifically smartphones and tablet computers (such as the iPad), instead of laptop computers. These devices are generally owned and used by learners. They offer a sense of *personalisation* that is related to ownership. Ownership has been linked to intrinsic and extrinsic motivation, which may lead to positive learning outcomes and enable the growth of m-learning in higher education. Another advantage of using personal mobile devices is that the institution need not devote time and resources to procure devices when most learners already own devices that support m-learning. As has been said earlier, although ownership amongst the learners who participated in this study is relatively low, national and global trends in the telecommunication industry indicate that this is likely to grow within the next few years.

This study was therefore undertaken to measure the attitudes that learners have about the use of QR codes in m-learning, and this is critical because positive experiences and attitudes will encourage participation and acceptance of use of QR codes. in enhancing m-learning in an ODL environment, particularly one that relies on a blended learning approach.

In any perception study, the first and most important fact that needs to be established is the learners' level of awareness, and in this particular study, on the use of QR codes in m-learning. The findings of this study suggest that while the majority of learners in OUM are aware of QR codes, only a fifth of them have any experience using QR codes. This observation could be due to the fact that only 48.4% of the learners who participated in the survey owned a smartphone; and 27.4% owned a tablet computer. These figures suggest that accessing learning materials via smartphones or tablet computers is currently still something very novel and might not be immediately applicable as a blanket measure. However, it is worth reiterating that despite a low ownership at present, learners were deemed to be moderately efficient in using computer technology, with an average rating of 2.97 out of 4.00 points.

Overall, the study indicates that OUM learners viewed the use of QR codes favourably for learning, as the mean ratings for learners' attitude, usefulness and ease of use of QR codes were high; i.e. between 3.10 to 3.23 out of 4.00 points. This finding is consistent with the findings of previous research on m-learning (albeit not concerning QR codes) that were supported with extensive data mainly from learner surveys and experimental studies (Clarke, *et al.*, 2008; Wang, *et al.*, 2009). In the present study, tutors for each of the eight courses were requested to obtain feedback from their learners after using QR codes. Generally, the reports indicated that most learners were excited and a great deal of interest was generated during the tutorial sessions. Of the eight courses involved in this study, learners from seven courses reported having a strong

positive reaction to using QR codes. They requested more questions, as they found that the modelled questions and answers helped them to understand the topics better. They also found that learning was more enjoyable as they were able to interact with their peers, by sharing their own experiences in using the QR codes to access the given materials. The tutors also reported that learners found the QR codes convenient, quick and efficient and renders learning more flexible and portable; factors that suited their needs and preferences. These factors contribute to the high satisfaction rates given by learners in their experience with QR codes.

The simplicity and convenience of the system are the most compelling reasons for their favourable evaluation of the exercise; as the URL of iLectures and Q&A exercises that they scanned using the different QR codes are automatically saved in their devices and the materials saved in the 'history' can be retrieved whenever or wherever required without having to be connected to the Internet. A bigger advantage is that once scanned, the materials can be used as many times as possible at their own convenience. In addition, the use of QR codes eliminate the pesky issue of keyboard input. Learners need not key in complicated and long web addresses that may be impossible to remember or easily mistaken. All is needed is a quick scan with a camera, and a learner is on his/her way to m-learning. The use of the QR codes also improves learning – learners can appreciate the solutions to the problems posted, and most of them admitted that the system is suitable for working adults who are always busy during working hours. The only constraint is that learners need to have the smartphones or tablet computers to access the materials provided.

There are however, a small percentage of learner respondents who were dissatisfied, and the reasons are mainly due to the fact that in the first place, they do not own a smartphone or are reluctant to pay for the Internet charges. They suggested that OUM bears some of these costs if the university is to encourage a more pervasive use of such a system. Additionally, a few complained of a lack of Internet access at OUM's learning centres, making it difficult for them to make full use of the QR codes. Some were of the opinion that the devices' limited capacities might make it unsuitable for learning purposes. A few learners also complained on the poor quality of one of the iLectures as viewed through YouTube. OUM will need to look into this to ensure that time spent by learners in going through the lecture material is really worthwhile and beneficial.

With any new device or technology that is introduced to learners, there is always the element of anxiety. In this study, the level of anxiety related to using the system of QR codes, smartphones and tablet computers was at 2.35 out of 4.00 points. Tutors can play an important role in allaying

learners' fears so that they are more comfortable and at ease when using the system. Greater interaction while going through the experience of using the QR codes amongst learners as well as between learners and their tutors will help reduce anxiety and this will ultimately lead to an increase in the use of the system.

It is also gratifying to note that learners' intention to continue using QR codes was above average, with usefulness and satisfaction being the most significant factors that impact the learners' intention to continue using QR codes. This finding suggests that the learning material must be of high quality, they must be clearly presented, and that they are useful and improves understanding of the topics covered and add value to the entire learning process. ICT infrastructures need to be improved as well, if OUM intends to establish a more advanced learning environment that leverages on technology. At the very least, broadband and WiFi connections need to be upgraded at all its learning centres. This study is of utmost importance to OUM as it has already developed numerous learning resources in many different formats to assist learners in their studies, including the iLectures. The use of QR codes in a classroom setting, as exemplified in this study, is expected to compel learners to fully utilise these readily available resources. In this regard, both the university and learners can truly benefit.

7. CONCLUSION

Although the amount of research in the area of m-learning has increased over the last few years, most of them seem to focus on learners' perception with regard to specific intervention measures, largely ignoring large scale m-learning initiatives that have potential for infusion into classes as an academic tool for any course. This is the first publication related to the use of QR codes in enhancing m-learning in an open and distance learning environment by focusing on some selected topics from some *high risk* courses at OUM. It is gratifying to know that learners appear to be very positive on a system that uses QR codes, smartphones and tablet computers. In light of the findings that learners' intention to continue using QR codes is dependent on their usefulness and satisfaction, OUM should prioritise all digital/online materials according to their usefulness and quality.

As a way forward, it would also be helpful to create a database of all learning materials that have been encoded as QR codes. This will enable easy access by learners, tutors and subject-matter experts. Based on the open-ended questions and feedback, learners seem sufficiently ready to adopt the use of such a system. However, faculty members may need more time, experience and training in the use of QR codes as part of the m-learning system in teaching and learning. In

order to acculturate the use of QR codes, perhaps the time has come to allow the updates to the university website and learning management system (known as myVLE) to be encoded as well in order for them to be viewed in a mobile format. Increased dialogue among learners and faculty members about the learning opportunities available through use of QR codes/mobile devices will further increase awareness among both learners and staff. Finally, it may be a good idea for OUM to partner with telecommunications operators and telephone companies in subsidizing the costs of purchasing mobile devices and/or data plans for learners and faculty members. This will definitely spur greater use of smartphones and tablet computers, and with the inclusion of QR codes, m-learning will be rendered more ubiquitous, particularly among adults who are already immersed in a blended learning environment. This study will serve as a starting point for more in-depth studies that could focus on how the use of QR codes and personal mobile devices impact teaching and learning.

In conclusion, this project has indicated that the system of integrating QR codes and learning materials using smartphones and tablet computers has the capacity to enhance m-learning and at the same time promote lifelong learning at OUM. As smartphones become more ubiquitous, and as capabilities increase, the demand for instant communication and access to learning materials will continue to rise and today's education must meet that challenge..

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